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Parasitism of *Diachasmimorpha tryoni* (Hymenoptera: Braconidae) on the host *Ceratitis capitata* (Diptera: Tephritidae) under Mediterranean temperatures

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Abstract *Ceratitis capitata* (Wiedemann, 1824) is an endemic citrus pest since the 1930s in the East Coast of Spain, where biological control against the medfly was attempted in those first years without any success. In 2003 the Valencian Institute of Agricultural Research (IVIA) began a project to study new possibilities of use of Hymenoptera parasitoids in order to include them in Integrated Pest Management strategies against the Medfly in the Mediterranean Coast of Spain. With this aim the braconid wasp *Diachasmimorpha tryoni* (Cameron, 1911) was imported from Hawaii and a laboratory rearing of this species is in progress in the IVIA facilities. *D. tryoni* has a high parasitism and emergence rates at 25°C and at 21-25°C. The critical temperature of 30°C prevents the emergence of a new generation of parasitoids, but females are able to parasitize the host. When these high temperatures (25-30°C) are applied only for a few hours the parasitoid development is completed and adult emergence occurs. These results can explain the potential adaptability and survivorship of the parasitoid in the Mediterranean high temperatures when field releases are carried out to control the Medfly summer populations. Consequently, parasitism can be successful in the warmer months of the Mediterranean Spanish area.

Key words: *Ceratitis capitata*, *Diachasmimorpha tryoni*, Medfly, parasitoid, biological control, temperature, parasitism rate, emergence rate.

Introduction

Diachasmimorpha tryoni was imported from Hawaii in 2002 by the Valencian Institute of Agricultural Research in order to attempt the classical biological control against *Ceratitis capitata* in Spain (Falcó *et al*., 2003). This parasitoid is being used in several successful control programs in Central and South America. In Spain it was imported in 1932, but difficulties in transport and rearing processes made the field control program to fail.

The braconid *Diachasmimorpha tryoni* is a solitary koinobiont parasitoid that begins its life cycle laying the eggs on the third instar larvae of the Medfly, then the parasitoid complete its larval and pupae development inside its host. Finally a new parasitoid adult emerge from the puparium. Several authors have discussed some aspects of the biology of *D.tryoni* including references to temperature and rearing parameters (Ramadan *et al*., 1989; Wong *et al*.,1990; Hurtrel *et al*., 2001; Falcó *et al*., 2003) but it is necessary to know thermal requirements of parasitoid and host as well as its effects on parasitism in order to understand the best conditions for release actions as a part of control programs in the Mediterranean area.

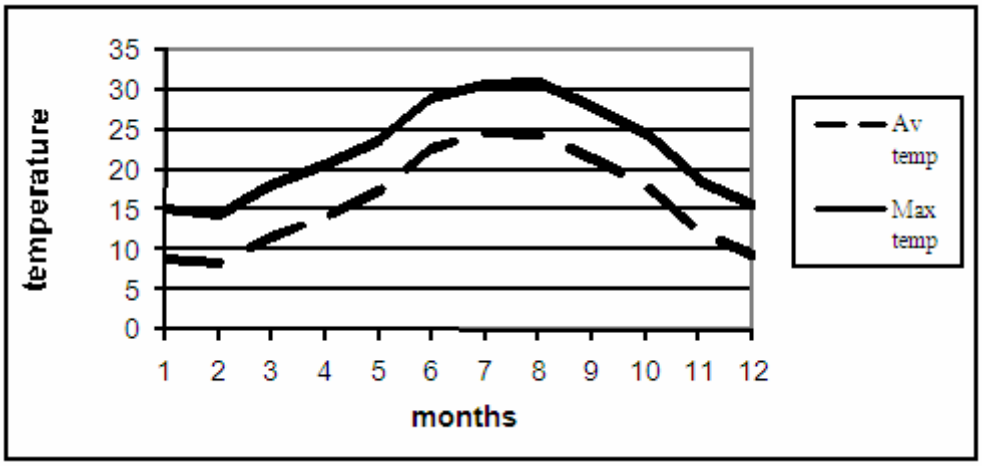

Figure 1: Temperatures of the Citrus area of Valencia (Source: National Institute of Meteorology (INM))

In the Mediterranean east coast of Spain the average temperature is 20-25ºC along four months in summer but the average of maximun temperatures can reach up to 30ºC (Figure 1).

A lack of information about parasitism of *D. tryoni* on the Medfly at 30ºC has been detected as well as the evaluation and comparison of the effect of potentially high Mediterranean temperatures on emergence and parasitism rates. These data can help to assess how temperature affects the possibilities for field releases of *D.tryoni* as a potential biological control agent of the Medfly in the Spanish Mediterranean area along spring and summer periods.

Material and methods

Test temperatures

The tempeatures of the assays were the following ones: 21-25ºC range when the parasitoid is active, and the Medfly attacks the citrus fruits, 25ºC optimal temperature to development and emergence rates for the parasitoid (Hurtrel *et al*., 2001), 30ºC maximal temperature for the development of the parasitoid progeny (Hurtrel *et al*., 2001), and 25-30ºC variable temperature to confirm the parasitoid survivorship subjected to critical high temperature for four hours.

Mass rearing

The Medfly and parasitoid are stablished under rearing conditions in the laboratory of Entomology at the IVIA. The rearing of *Ceratitis capitata* is based in the method proposed by Albajes and Santiago-Álvarez (1980). The laboratory conditions are: fotoperiod of 16:8 (L:D), relative humidity of 75±5% and temperature of 26±1ºC in the light period and 21±1ºC in the darkness period.

The parasitoid rearing was initiated in 2002 with the population that was imported from the laboratory of the U.S Pacific Basin Agricultural Research Center (USDA-ARS- Hawaii). The third instar larvae of he Medfly are offered to adults of *D. tryoni* for 24 hours, then the host larvae are collected and continue the development forming the puparia. 18-20 days after parasitism the new generation of *D. tryoni* emerges from the host puparia (Falcó *et al*., 2003).

Methodology

The experiments were based on solitary parasitoid females previously mated. 20 Medfly larvae were offered to parasite during 24 hours in parasitism cages, daily along its life. Each day the potential parasitized larvae were moved to emergence boxes.

After development period, all the Medfly and parasitoids emerged as well as their puparіums were noted. Closed puparia were dissected to check inside them the presence of preimaginal instars or not emerged adults both of parasitoids and flies. Also the superparasitism cases were evident. The parameters that are studied were the following: Total emergence rate, Daily emergence rate, Total parasitism rate, Daily parasitism rate.

Statistical analyses

The statistical analyses at 3 levels of temperature (21-25ºC, 25ºC and 25-30ºC) were made to the studied biological parameters with the statistical package S.A.S 9.1. Emergence and parasitism have binomial distribution so a logistic regresion with the statistical package SAS was performed. These parameters are compared between temperatures with contrasts and with a significant level of 0.05.

Results and discussion

The parasitism rate is evaluated with puparia from which emerge adult parasitoids and with closed puparia including preimaginal instars and not emerged adults of the parasitoid (Figures 2 and 3). The results are shown in the graphic below. At 25ºC and 21-25ºC there is the higher percentage of parasitism (38.40±2.51% and 38.37±3.05% respectively). These temperatures are included in the range of temperatures of a high activity of the Medfly.

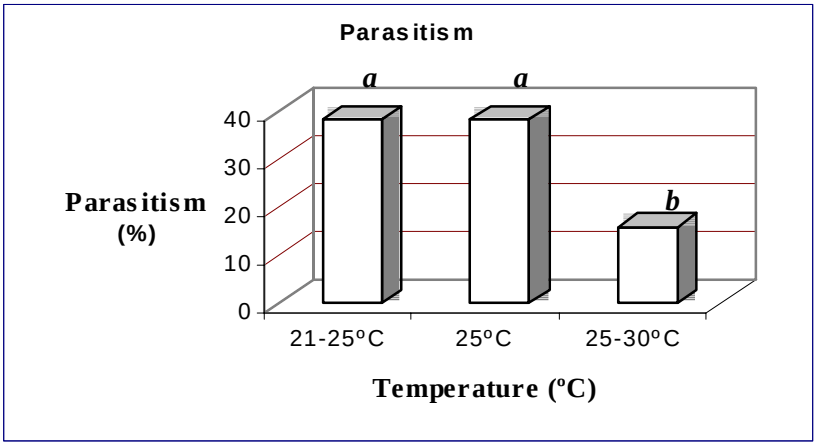

Figure 2: Parasitism rates of *D. tryoni* at different temperatures.

The daily parasitism (Figure 3) is irregular until the second week of the female age when it begins to decrease.At 25-30º the line tendency is different with a 50% of parasitism peak in the middle of female life and posterior very low parasitism; but this parasitism rate and the emergence (Figures 4 and 5) could assure the parasitoid population at the higher variable temperatures.

The highest total emergence rate is reached at 25ºC (28,74 ±1,81) but there are not statistical differences with 21-25ºC. The emergence of females is higher at the lowest variable temperatures but it shows similar statistical differences as before. The emergence at 25-30ºC is clearly statistical different to other tested temperatures.

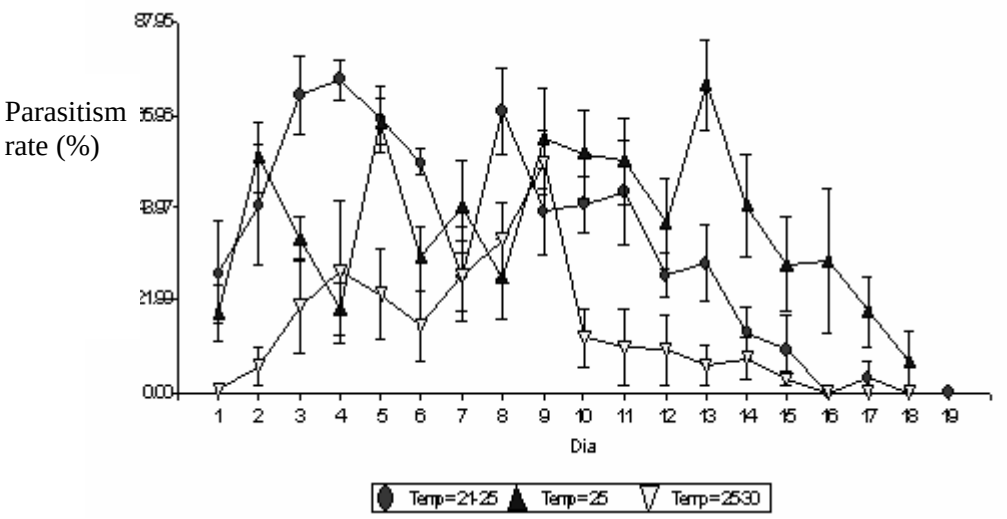

Figure 3: Daily parasitism of *D. tryoni* at different temperatures.

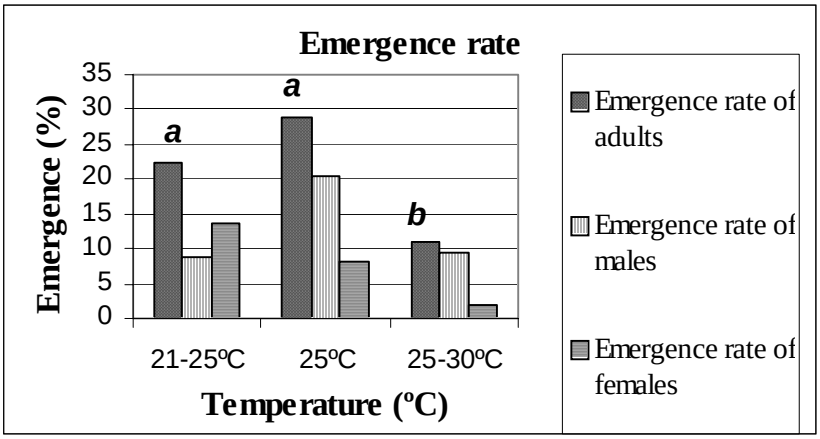

Figure 4: Emergence rate of *D. tryoni* at different temperatures.

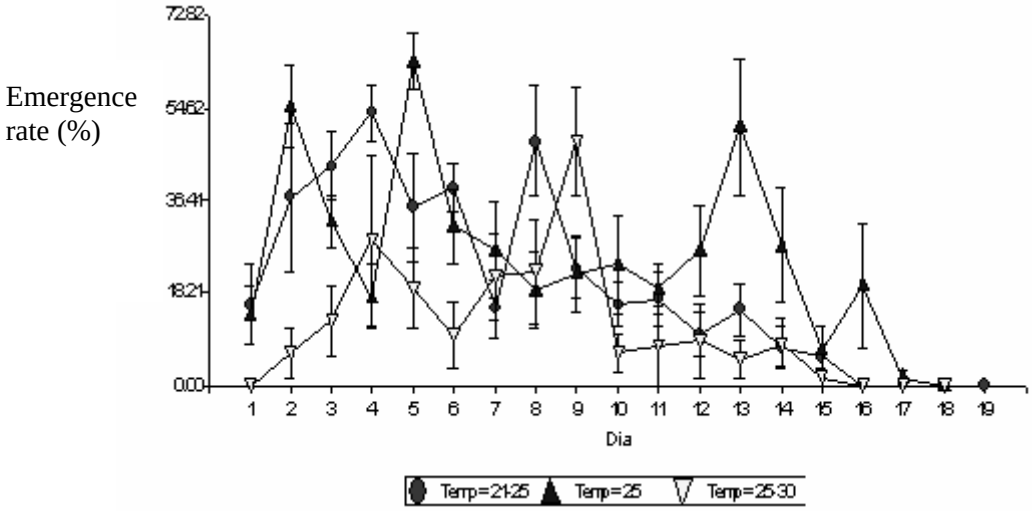

Figure 5: Daily emergence of *D. tryoni* at different temperatures.

The daily emergence (Figure 5) shows the same response at the different temperatures in relation with the daily parasitism rates.

The tested temperature of 30ºC is the maximal temperature that prevents the emergence of the parasitoid *Diachasmimorpha tryoni* (Hurtrel *et al*., 2001). Parasitism was tested at this temperature but, according to literature, no parasitoid emergence ocurred. In this test a total of 1066 closed puparia has been dissected to check the parasitoid preimaginal instars or not emerged adults inside them. 52% of the examined closed puparia include at least one first instar larvae of the parasitoid. So although there is no emergence of the progeny but the female is actively searching for the host and parasitism exists at 30ºC. It could contribute to reduce Medfly population even at this maximal temperature.

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